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Research Report 1317

TRAINING AND RETENTION OF ARMOR MACHINEGUN TASKS

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ARI FIELD UNIT AT FORT KNOX, KENTUCKY

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Platoons within three Armor One Station Unit Training (OSUT) companies were assigned to one of three M85 training schedules: a single four-hour block, two four-hour blocks received in one day, or two four-hour blocks separated by at least one week. One of the three companies was also shown videotaped demonstrations of M85 tasks. GO/NO GO data on M85 and M240 tasks were gathered by evaluators from the Directorate of Plans and Training (DPT) at Fort Knox. M85 performance was measured at the end of the OSUT cycle, whereas M240 scores were

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gathered at both mid- and end-of-cycle tests. In addition to GO/NO GO performance, ARI data gatherers collected execution times on M240 tasks.

The findings included: (a) no effect of training schedule and introduction of videotaped demonstrations on M85 task performance or M240 retention; (b) poor performance on M85 mechanical training tasks which the OSUT personnel did not expect on the end-of-cycle test; (c) reliable decreases in M240 performance between mid- and end-of-cycle tests; and (d) task execution times revealed subtle changes in performance not shown by GO/NO GO scores.

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FOREWORD

The Fort Knox Field Unit conducts research on human performance in Armor systems. The Weapon Systems Training Team is specifically concerned with training factors that control acquisition and sustainment of task performance.

Procedural tasks are particular performance problems on end-of-cycle tests in Armor One Station Unit Training (OSUT). A previous study indicated that retention failure is a factor in these performance problems. Thus, instructional changes designed to sustain skills should improve procedural task performance on end-of-cycle tests. However, Armor OSUT is a complex training program including instruction on many related tasks. Consequently, training improvements in one task area could prove detrimental to performance in a similar area.

Formal training on the M85 commander's machinegun was increased and distributed, and a videotaped demonstration of procedures was introduced. Test results showed that these changes had no effect on either M85 performance or performance on a similar weapon, the M240 coaxial machinegun. However, there was evidence that the effects of the instructional changes were obscured by unscheduled retraining sessions which occurred between formal training and testing. These findings suggest that the effects of well-founded training fixes may be overshadowed by effective practice occurring outside of formal training. This research should aid Armor OSUT managers in implementing effective procedural training.

JOSEPH ZEIDNER
Technical Director

TRAINING AND RETENTION OF ARMOR MACHINEGUN TASKS

BRIEF

Requirement:

To evaluate the results of changes to instruction on the M85 commander's machinegun. Specifically, the research assessed the effects of the changes to M85 training on M85 test performance and retention of M240 coaxial machinegun tasks.

Procedure:

Platoons within three Armor One Station Unit Training (OSUT) companies were assigned to one of three M85 training schedules: a single four-hour block, two four-hour blocks received in one day, or two four-hour blocks separated by at least one week. One of the three companies was also shown videotaped demonstrations of M85 tasks. GO/NO GO data on M85 and M240 tasks were gathered by evaluators from the Directorate of Plans and Training (DPT) at Fort Knox. M85 performance was measured at the end of the OSUT cycle whereas M240 scores were gathered at mid- and end-of-cycle tests. In addition to GO/NO GO performance, ARI data gatherers collected execution times on M240 tasks.

Findings:

1. Changes to the training schedule and the introduction of videotaped demonstrations did not affect M85 task performance or M240 retention.

2. Results showed poor performance on M85 mechanical training tasks which OSUT personnel were not expecting on the end-of-cycle test.

3. Performance on M240 tasks reliably decreased between mid- and end-of-cycle tests.

4. Task execution times were useful adjuncts to GO/NO GO scores for showing subtle changes in behavior over time.

Utilization of Findings:

Results should be of interest to training managers in the U. S. Army Armor Center as well as managers of other military training programs. The measurement issues should be of interest to those interested in retention of military skills.

TRAINING AND RETENTION OF ARMOR MACHINEGUN TASKS

CONTENTS

APPENDIXES

LIST OF TABLES

LIST OF FIGURES

TRAINING AND RETENTION OF ARMOR MACHINEGUN TASKS

MANAGEMENT SECTION

INTRODUCTION

In evaluating the status of Armor One Station Unit Training (OSUT), the Office of Armor Force Management and Standardization (OAFMS) reported inadequate end-of-cycle performance in a number of task areas (OAFMS, 1980a). One of the problem areas cited in the report was mechanical training of the M85 commander's machinegun. Morrison and Bessemer (1980) suggested that the performance deficit was due to a failure of OSUT personnel to retain mechanical training skills. The present research assessed the effects of changes to M85 instruction designed to enhance retention of mechanical training skills thereby increasing end-of-cycle performance. The research also examined possible detrimental effects of these changes on retention of tasks on a similar weapon, the M240 coaxial machinegun.

Training Schedule

The Armor OSUT Program of Instruction (POI) specifies that one four-hour block of instruction is devoted to M85 mechanical training. It is obvious that the addition of another four-hour block would allow for increased levels of skill acquisition and retention. Less obvious, however, is the appropriate schedule for additional training. Research indicates faster learning of motor tasks under spaced as opposed to massed schedules (e.g., Ammons, 1951). Learning theorists have frequently interpreted the inferiority of massed performance as being due to the temporary effects of boredom or fatigue since the difference is often short-lived (Schendel, Shields, and Katz, 1978). However, Baddeley and Longman (1978) cautioned that such conclusions are based on experiments which distribute the time between successive trials of learning tasks rather than the time between training sessions. Data from their typing skills program showed superior learning and retention for spaced over massed training sessions. Therefore, spacing the two four-hour blocks of M85 training may promote retention of mechanical skills over presenting the blocks back to back. Accordingly, the present research directly examined the effect of the number and distribution of M85 training sessions on end-of-cycle performance.

Demonstration Media

Observations of M85 mechanical training suggests another possible improvement to instruction. Because the M85 machinegun is heavy and bulky, the weapon must remain on a table in order for the instructor to demonstrate the procedures. As a result, demonstrations are not always visible to the OSUT soldiers, especially those seated at the rear of the class. Audiovisual presentations can provide better demonstrations by showing angles of view not possible in live demonstrations. Such tapes of M85 procedures are available through the Armor School. Further, Armor OSUT classrooms are typically equipped with videotape players and several monitors. Thus, the M85 videotape

provides a possible useful adjunct to mechanical training. Consequently, the current study compared the relative effects of videotaped versus standard instructor demonstrations on M85 performance at the end-of-cycle.

Retention of M240 Training

Training and testing on the M240 coaxial machinegun occurs prior to mechanical training of the M85. Because the two machineguns are similar in many respects, changes to M85 training could affect retention of M240 tasks. To the extent that M85 procedures differ from those of the M240, M85 training might interfere with M240 retention. On the other hand, the M85 training may reinforce general mechanical principles resulting in a facilitation of M240 retention. The present experiment provided a retest of M240 tasks at the end-of-cycle to measure retention of M240 skills, and assessed possible effects of changes to M85 instruction on M240 retention.

OBJECTIVES

. To assess the effects of different M85 training schedules on end-of-cycle test performance.

. To evaluate the outcome of videotaped and instructor demonstrations of M85 procedures on end-of-cycle test performance.

. To measure the retention of M240 tasks across the training cycle, and to assess the effects of changes to M85 training on M240 retention.

PROCEDURES

Three training companies from 1st AIT/OSUT Brigade at Fort Knox provided performance data for the present research. Platoons within companies were assigned to one of three training schedules: a single, four-hour block of training (standard); two, four-hour blocks delivered in successive morning and afternoon sessions (massed); or two, four-hour blocks separated by at least one week (spaced).

The standard and massed schedule conditions of one training company were shown videotaped demonstrations on the clearing, disassembly, and assembly of the M85; instructors demonstrated loading and immediate action tasks. In the other companies and conditions, instructors demonstrated all five mechanical training tasks.

Personnel from the Testing Branch of the Directorate of Plans and Training (DPT) assessed M85 GO/NO GO performance as part of the regular end-of-cycle test. Two versions of the end-of-cycle test were then current. With respect to the M85 station, the test versions required different subsets of the five mechanical training tasks: clearing, disassembly, assembly, loading, and immediate action. For the purposes of the present study, however, all three companies were tested on all five tasks.

M240 GO/NO GO data were also gathered by DPT testers as a part of the regular mid-cycle evaluation. Both versions of the mid-cycle test required all five mechanical training tasks. To supplement the dichotomous GO/NO GO scores,

ARI data gatherers collected task execution times on a subsample of soldiers from each training company. The subsamples were called back at the end-of-cycle for a retest on M240 tasks.

RESULTS AND DISCUSSION

M85 Performance

Analyses of M85 test performance at the end-of-cycle showed no consistent differences between the three training schedules. Furthermore, results revealed no systematic differences between platoons that saw videotaped demonstrations and platoons that received standard instructor demonstrations. A probable reason for the lack of differences was the effect of nonscheduled training which occurred in the 3-week interval between M85 classes and the test. Conversations with the drill instructors revealed sufficient motives and opportunities to supplement formal classroom training, especially on difficult subjects such as the M85. The intervening practice probably compensated for any performance differences due to changes in classroom training.

Prior to the experiment, it was assumed that the drill sergeants were not told the test version assigned to his unit so that all five tasks would be trained. Indeed, observations of mechanical training classes showed that all five tasks were covered with no particular emphasis on any one task. However, discussions with training and testing personnel during the course of the experiment revealed that drill sergeants knew the assigned end-of-cycle test version perhaps as early as before the mid-cycle test.

According to test version assignment, the first two companies expected to be tested on clearing, loading, and immediate action tasks whereas the third company expected clearing, assembly, disassembly, and immediate action. Thus, the tests differed with respect to disassembly, assembly, and loading task. Table 1 presents test performance on these tasks as a function of whether or not the training company expected the task at the end-of-cycle. The data indicated that, not only were the training cadre aware of test version, but that they also trained their men accordingly. Because no differences were observed in classroom instruction, it was inferred that test-specific training was conducted during nonscheduled sessions. Thus, these results also attested to the effectiveness of the informal training between the class and the test.

M240 Performance

Differences between mid- and end-of-cycle performance. Tables 2 and 3 present comparisons of performance at the two M240 test administrations for GO/NO GO rates and task execution times respectively. Both sets of data show large and significant declines in clearing, assembling, and loading task performance. Thus, for these tasks, the results presented unambiguous evidence for skill loss over the course of the OSUT cycle.

The performance loss on the disassembly task was significant for the execution times but not for the percentage of GOs. The failure to obtain a significant decrease in percent passing the disassembly task was due to the performance ceiling inherent in the measure. That is, performance changes

TABLE 1

PERCENT PASSING END-OF-CYCLE TEST FOR COMPANIES

EXPECTING OR NOT EXPECTING M85 TASKS

Tasks	Expected: Yes	Expected: No	χ^2 [a]
Disassemble	94.9	81.2	13.90**
Assemble	68.4	42.9	23.83**
Load	86.3	60.3	35.99**

[a] Chi-square test for differences in proportions

**$p < .01$

TABLE 2

PERCENT PASSING M240 TASKS ON MID-AND END-OF-CYCLE TESTS

Task	Test: Mid-Cycle	Test: End-of-Cycle	z^a
Clear	78.8	59.0	3.72**
Disassemble	100.0	97.4	1.00
Assemble	95.5	83.8	3.10**
Load	96.8	87.1	2.92**
Immediate Action	85.7	79.2	1.42

[a] McNemar's test of differences between correlated proportions

**$p < .01$

TABLE 3

MEANS AND STANDARD DEVIATIONS OF TIMES (SECONDS) TO EXECUTE M240 TASKS ON MID- AND END-OF-CYCLE TESTS

Task		Test: Mid-Cycle	Test: End-of-Cycle	*t*[a]
Clear				
	$\overline{X}$	16.0	19.0	7.44**
	SD	4.14	5.97	
Disassemble				
	$\overline{X}$	37.2	52.2	10.08**
	SD	7.76	18.59	
Assemble				
	$\overline{X}$	65.4	88.4	9.94**
	SD	18.90	30.00	
Load				
	$\overline{X}$	15.0	17.5	3.86**
	SD	4.19	7.24	
Immediate Action				
	$\overline{X}$	35.4	35.0	0.55
	SD	7.90	6.86	

[a]*t* - test of differences between correlated means

**$p < .01$

were masked because the percent passing was near the upper limit of 100%. In contrast, the task execution times were less constrained by floor or ceiling limitations in measurement. Consequently, only the time-based measure showed significant declines in disassembly performance.

In contrast to the other four tasks, the immediate action task data did not evidence performance losses in either percent GO or execution times. The lack of retention losses may be traced to the fact that immediate action was tested last at both assessments. By way of explanation, immediate action can be broken into five subtasks: attempt to fire, clear, hand cycle, reload, and attempt to fire a second time. Immediate action losses were minimized on the end-of-cycle test because the soldiers received practice and feedback on clearing and loading subtasks immediately prior to being retested. Similar research findings have shown that components of tasks are effective in "reactivating" memory for the entire task (see Spear, 1978 for summary).

Effects of changes to M85 training. Analyses of M240 data showed that differences between mid- and end-of-cycle test performance were not related to changes in M85 instruction. Thus, neither M85 training schedule nor demonstration media had an effect on M240 retention.

Time and accuracy. Because time itself was listed as the reason for receiving a NO GO on M240 tasks in only a small proportion of cases (<7%), the relationship between execution time and accuracy was examined more closely. The first general finding was that NO GOs were slower than GOs. Two possible explanations of this difference may be advanced: The inaccurate performers may have remained actively engaged in the task while testing out inaccurate or inefficient procedures, or the incorrect performer paused longer and/or more often while searching memory for the appropriate procedure. Future research should distinguish between time on and time off task in order to better understand the individual differences in task execution time.

The second general finding was that accurate as well as inaccurate performers showed retention decrements in timed performance. This fact jibed with the disassembly results, which showed losses in execution time even though accuracy was near a ceiling of 100% passing. Thus, for the present research, task execution times proved to be sensitive indicants of performance change.

CONCLUSIONS

1. Changes to the training schedule and the introduction of videotaped demonstrations did not affect M85 task performance on the end-of-cycle test. Nonscheduled training between class and test apparently lessened the impact of classroom training on test performance.

2. M85 task performance varied as a function of test version assigned to training companies. Findings indicated poor performance on tasks which the soldiers (and trainers) did not expect on the end-of-cycle test.

3. Accuracy and timed performance on M240 tasks decreased over the period between mid- and end-of-cycle tests in Armor OSUT. However, these M240 skill losses were not related to changes in M85 training.

4. Task execution times were able to detect subtle changes in behavior not indicated in GO/NO GO scores. Thus, the time-based measures provided a useful supplemental retention index.

TECHNICAL SUPPLEMENT

Training and Retention of Armor Machinegun Tasks

METHOD

Participants

In coordination with 1st AIT/OSUT Brigade and the Scheduling Branch of DPT, four consecutive Armor OSUT companies were assigned to the present research. Errors in treatment assignment for the fourth company prevented their inclusion in this research. M85 task performance data were gathered on all soldiers in the remaining three companies (N = 419). Overall M240 retention performance was measured on a subsample from each of the four companies (N = 155), but treatment comparisons only included subsamples from the first three companies (N = 107).

Weapons

The M85 machinegun is a .50 caliber weapon mounted in the commander's station of M60 series main battle tanks. The M240 machinegun is mounted coaxially with the main gun of the M60 and uses 7.62 mm ammunition. Both weapons are gas-operated, belt-fed, and air-cooled with fixed headspace and timing. The M240 is the smaller and lighter weapon (10.3 vs. 29.5 kilograms), and is field stripped into fewer parts (9 vs. 15). Because of their mechanical similarities, clearing, loading, and immediate action tasks are similar for the two weapons. However, there are some differences in specific steps which are potentially interfering to soldiers. For instance, the M240 is loaded with the bolt to the rear whereas the M85 is loaded with the bolt forward. Recent performance data (OAFMS, 1980a) indicated that M240 procedures are somewhat easier than M85 ones: Twenty-four percent of OSUT students failed at least one M240 task whereas thirty-four percent failed an M85 task.

Training Schedule

The then current (December, 1978) Armor OSUT Program of Instruction (POI) assigned eight hours of M240 mechanical training to be conducted in two, four-hour blocks prior to the mid-cycle evaluation (week 7 of the 13-week training cycle). The first block of M240 training was devoted to demonstration and hands-on practice on five tasks: clearing, disassembly, assembly, loading, and immediate action. The second M240 block was a review of the first with more emphasis on hands-on practice. In contrast, the POI assigned only one, four-hour block of M85 training which provided demonstrations and practice on all five tasks. This block was commonly presented on the week after the mid-cycle test (week 8). The six platoons of an OSUT company were normally assigned to M85 and M240 classes in pairs: 1st and 2d; 3d and 4th; 5th and 6th. Platoons 1 through 4 were trained as gunner/loaders (MOS 19E) with 5 and 6 trained as drivers (MOS 19F).

Given the scheduling restrictions, pairs of platoons were assigned to one of three experimental M85 training schedules: a) standard: one, four-hour block scheduled for the 10th week of training; b) massed: two, four-hour blocks received on a single day in the 10th week of training; c) spaced: two,

four-hour blocks of training, one in the 8th and one in the 10th week of training. Following the M240 format, the second blocks of M85 training in massed and spaced schedules were devoted to review of the first block; i.e., no new topics were covered.

Table 4 illustrates the assignment of platoons to training schedules. As can be seen, differences between schedules were orthogonal to training company differences. However, because the authors had limited control over platoon assignment, platoon differences were not successfully counterbalanced across the training schedules. Inasmuch as schedule contrasts were confounded with possible MOS group differences, end-of-cycle test performance of gunner/loaders and drivers was compared. Recent data from OAFMS (1980b) showed small differences between the two MOSs on M85 tasks. Table 5 shows that, despite the large samples compared, statistical tests detected no significant differences between MOSs on clearing, assembly, loading and immediate action tasks. A small (5.8%) but significant difference favoring drivers was obtained on the disassembly task. Even for this task, the data indicated no substantial bias should result from the MOS imbalance between schedules.

Videotaped Demonstrations

The videotape was entitled "M85 Machinegun" (FK-ARS-41-74), and was produced by DPT-TV Branch. It consisted of a 15 minute and 48 second color demonstration of clearing, disassembly, and assembly of the M85. OSUT classrooms were each equipped with 4-5 television monitors distributed about the room.

Due to scheduling problems, the videotape was shown in only two schedule conditions of the third company: The videotape was presented once to the standard condition and twice to the massed condition (once in each of the two blocks). Because the videotape was shown to only one company, the videotape/instructor demonstration contrasts were completely confounded with training company differences.

Performance Tests

M85 tests. Performance data on the M85 were gathered by testers from the Test and Evaluation Branch of DPT as a part of their regular end-of-cycle evaluations of OSUT students. Following DPT standard operating procedures, testers rotated stations between training cycles. Consequently, each training company was evaluated by different testers. Students were tested collectively (up to 18 at one time) on mechanical training tasks. The M85 station was manned by 2-3 testers who scored students as GO or NO GO on each of the individual tasks. Students who committed any procedural error or exceeded time standards were classified as NO GOs for that task. Time standards for the M85 tasks were: one minute for clearing; five minutes for disassembling; five minutes for assembling; one minute for loading; and three minutes for applying immediate action.

At the time of this research, two versions of the end-of-cycle test were being administered to OSUT companies. Version A included the tasks of clearing, disassembling, assembling, and applying immediate action; whereas Version B tested clearing, loading, and immediate action. For all stations other than

TABLE 4

ASSIGNMENT OF PLATOONS TO TRAINING SCHEDULES

Company	Schedule: Standard	Massed	Spaced
1	3 & 4 (N = 52)	1 & 2 (N = 56)	5 & 6 (N = 44)
2	3 & 4 (N = 42)	5 & 6 (N = 48)	1 & 2 (N = 42)
3	3 & 4 (N = 45)	1 & 2 (N = 46)	5 & 6 (N = 45)

TABLE 5

PERCENT OF GUNNER/LOADERS AND DRIVERS

PASSING M85 TASKS DURING 4TH QTR FY 80

	MOS				
Task	Gunner/ Loader	(N)	Driver	(N)	χ^{2a}
Clear	90.5	(922)	89.4	(445)	0.34
Disassemble	92.1	(478)	97.9	(233)	8.84*
Assemble	74.2	(478)	78.1	(233)	3.06
Load	86.5	(444)	91.5	(212)	3.46
Immediate Action	82.3	(922)	84.0	(445)	0.61

[a]Chi-square test of differences between proportions

*$p < .05$

M85, the first two companies were assigned Version B of the end-of-cycle test while the third company got Version A. For purposes of the present research, each company was tested on all five mechanical tasks at the M85 station. However, only those tasks assigned to the regularly scheduled test version were counted towards the student's end-of-cycle evaluation.

M240 tests. Performance data on the M240 tasks were gathered by DPT testers as a part of their regular mid-cycle evaluations of OSUT soldiers. Much like the end-of-cycle M85 test, 2-3 testers evaluated up to 18 students at each session. In contrast to the M85 test, both versions of the mid-cycle test required all five mechanical training tasks. Time standards for the M240 tasks were: thirty seconds for clearing; two minutes for disassembling; two minutes and thirty seconds for assembling; one minute for loading; and one minute for immediate action. In addition to the GO/NO GO performance data, two ARI data collectors obtained task execution times for OSUT soldiers at each session. Task execution times were defined as the period from when the tester announced "begin" to when the soldiers indicated they were finished with the task. Because data collectors were practically limited to timing two soldiers apiece at any one session, times were taken for only four soldiers at each session. For the sake of viewing performance, the data collectors chose the four soldiers nearest their vantage point. Since students chose or were placed at test positions in an unsystematic manner, the subset of students receiving task times represented a reasonably unbiased sample of the total set of soldiers. Six weeks later, this subsample was called back for a retest of the M240 at the end-of-cycle. Retested soldiers were informed that results of the M240 retest would have no bearing on their end-of-cycle evaluation. Soldiers were retested four to a session by a single DPT tester who used the same conditions and standards as those required at mid-cycle. Two ARI data collectors recorded a second set of task execution times in the same manner as at the mid-cycle test.

RESULTS

Because of unequal cell sizes, all reported analyses of variance (ANOVAs) were calculated using least square solutions.

M85 Performance

Effect of training schedule. Table 6 lists the percentage of soldiers M85 tasks under each training schedule. Task performance does not appear to be related to training schedule. Schedule differences were tested by two-way ANOVAs (schedule X company) for each task separately (see Appendix A for summary tables). The analyses revealed no differences between schedules for the clearing, loading, and immediate action data. Disassembly and assembly results showed a significant schedule effect owing to poor performances under the massed schedule. However, significant schedule X company interactions indicated that the schedule differences were due to the poor performance of only two platoons under the massed schedule. In general, then, the M85 results showed no consistent differences between training schedules.

Effect of demonstration media. To determine whether televised demonstrations improved M85 performance, data from the first two training companies were combined to compare with the third unit, which was the only company to receive videotaped demonstrations. Because the videotaped demonstrations were shown

TABLE 6

PERCENT PASSING M85 TASKS BY TRAINING SCHEDULES

Task	Training Schedule		
	Standard	Massed	Spaced
Clear	92.1	94.7	90.1
Disassemnle	89.8	76.0	92.4
Assemble	59.8	44.0	50.4
Load	77.0	80.0	76.3
Immediate Action	76.3	84.0	76.3

to only standard and massed schedule conditions, the spaced schedule was excluded from the following comparisons. Table 7 displays percentage passing M85 tasks under the two demonstration and two scheduled conditions. The data show large but inconsistent differences between videotaped and instructor demonstration conditions: Whereas the videotaped condition was superior to the instructor condition for disassembly and assembly task performance, the relationship was reversed for the clearing and loading tasks. Two-way ANOVAs (demonstration X training condition) confirmed these differences to be reliable (see Appendix B). In sum, although differences were found between instructor and videotaped conditions, there was no consistent relationship between demonstration media and performance.

Effect of test preparation. To assess the possibility of units being prepared for a particular version of the end-of-cycle test, performance of the first two companies (assigned Version B) was compared with the third (assigned Version A). From the data in Table 8, it is clear that the OSUT companies performed better on a particular task if the task was expected on their end-of-cycle test. For instance, units assigned to Version A expected assembly and disassembly tasks and, consequently, performed better than the third company which did not expect these tasks according to test Version B. When the expectations were reversed for the loading task, the first two companies (Version B) were superior to the third (Version A). Interestingly, Version B companies performed slightly better than the Version A company on the two tasks that all three companies expected: clearing and immediate action. Although the difference in clearing performance was significant, these latter differences were less compelling than those related to differences in expectations. Finally, since the effects of demonstration media were completely confounded with test version assignment, the inconsistent differences between videotape and instructor conditions can also be attributed to differential test preparation.

In light of the evidence for informal test preparation, it was reasoned that little or no informal training was devoted to tasks not expected on the end-of-cycle test. By excluding the units expecting to be tested on a particular task, the influence of retraining could be minimized. Table 9 presents these data for each of the training schedules. Although performance is lower than the overall comparisons (cf. Table 6), the tabled relationships between schedules are very similar. ANOVAs (Appendix C) revealed significant differences between schedules for disassembly and assembly data. As in the previous analyses, these differences were largely due to the depressed performance of two platoons under the massed schedule. A likely interpretation of these data is that all tasks were reviewed during retraining but special emphasis was given to those tasks expected on the end-of-cycle test.

M240 Retention

Effect of M85 training schedule. Tables 10 and 11 present declines in GO/NO GO and timed M240 performance, respectively, for each of the three M85 training schedules. The few conditions in which performance improved between mid- and end-of-cycle are denoted by negative values. Although most conditions show performance declines, the magnitudes of the decrements are not related to training schedule. These data were tested for significance by mixed factor, three-way ANOVAs with subjects nested in schedule X company combinations and

TABLE 7

PERCENT PASSING M85 TASKS BY TRAINING SCHEDULE

AND DEMONSTRATION MEDIUM

Demonstration Condition	Training Schedule	
	Standard	Massed
Clear		
Instructor	93.6	97.1
Videotaped	88.9	89.1
Disassemble		
Instructor	88.0	67.3
Videotaped	93.3	95.7
Assemble		
Instructor	53.3	34.6
Videotaped	73.3	65.2
Load		
Instructor	86.2	91.4
Videotaped	57.8	54.4
Immediate Action		
Instructor	80.8	83.6
Videotaped	66.7	84.8

TABLE 8

PERCENT PASSING M85 TASKS FOR COMPANIES ASSIGNED

EITHER VERSION A OR B OF THE END-OF-CYCLE TEST

Task	Test Version A	Test Version B	χ^{2} [a]
Clear	86.8	95.1	9.01**
Disassemble	94.9	81.2	13.90**
Assemble	68.4	42.9	23.83**
Load	60.3	86.3	35.99**
Immediate Action	74.3	81.3	2.78

[a] Chi-square test for differences in proportions

**$p < .01$

TABLE 9

PERCENT PASSING UNEXPECTED M85

TASKS BY TRAINING SCHEDULE

Task	Training Schedule		
	Standard	Massed	Spaced
Disassembly	88.0	67.3	90.7
Assembly	53.3	34.6	41.9
Loading	57.8	54.4	68.9

TABLE 10

DECREMENT IN PERCENT PASSING M240 TASKS BETWEEN

MID-AND END-OF-CYCLE TESTS FOR THE M85 SCHEDULE CONDITIONS

Task	M85 Training Schedule		
	Standard	Massed	Spaced
Clear	22.0	3.0	15.0
Disassemble	2.4	0.0	2.5
Assemble	9.8	15.2	15.4
Load	19.5	6.1	12.5
Immediate Action	0.0	-6.2	10.0

TABLE 11

INCREMENT IN MEAN TIMES (SECONDS) TO EXECUTE M240 TASKS

BETWEEN MID- AND END-OF-CYCLE TESTS FOR M85 SCHEDULE CONDITIONS

Task	M85 Training Schedule		
	Standard	Massed	Spaced
Clear	2.3	2.3	4.0
Disassemble	14.3	15.0	16.0
Assemble	17.9	30.6	25.7
Load	1.2	1.8	2.8
Immediate Action	0.0	-9.9	-2.2

factorial to test administrations (see Appendix D and E for summary tables). Since retention was defined in terms of the test-retest contrast, the effects of M85 schedule on M240 retention were given by the schedule X test-retest interaction term. These terms were not significant for any of the analyses.

Effect of M85 demonstration conditions. Tables 12 and 13 show performance losses in terms of GO/NO GO and execution times, respectively, for the two M85 demonstration conditions. Again, performance improvements are shown by negative values. The clearing and loading task data show a slight tendency for the training company which received videotaped demonstrations to evidence smaller retention decrements than the two companies which received standard instructor-delivered demonstrations. Demonstration condition X test-retest interaction terms (Appendix D and E) were significant for both percent GO and timed performance on the clearing task, but only the execution times were significant for the loading task. Ironically, the instructor condition showed the only performance decrements in percent passing while the videotaped condition showed the only decrements for execution times. However, the demonstration X test-retest interaction term was reliable only for the time to execute the immediate action task. In sum, these data showed small and somewhat inconsistent differences in M240 retention between M85 demonstration conditions. Since the demonstration conditions had no direct effect on M85 performance, it is likely that the small differences in M240 retention were due to company differences rather than any retention benefits from the tapes.

Timed performance of GOs and NO GOs. Task execution times were classified on the basis of GO/NO GO performance on the mid- and end-of-cycle tests. Four different classifications were possible: A student could receive a GO at mid- and end-of-cycle (GG); a NO GO on both tests (NN); a GO at mid-cycle and a NO GO at end-of-cycle (GN); or a NO GO at mid-cycle and a GO at the end-of-cycle (NG). Too few students failed disassembly, assembly, and loading tasks on the mid-cycle test to perform meaningful statistical comparisons. Consequently, mid-cycle NO GOs were dropped, leaving only GN and GG combinations for these three tasks. To analyze the time-based performance, ANOVA designs set subjects nested in the GO/NO GO classifications and factorial to the two test administrations (see Appendix G for summary tables).

Figure 1 displays mean times and ns as a function of end-of-cycle GO/NO GO classification for the disassembly, assembly, and loading data. Interestingly, all three graphs show similar relationships. For one, both groups show increases in time between the two tests but GN increases are larger than GG increases. ANOVAs confirmed significant overall increases in times as well as reliable accuracy X test-retest interactions. Figure 1 also shows that GN subjects were slower than GG subjects at end-of-cycle but not at mid-cycle. T-tests confirmed significant differences between GN and GG subjects at the end-of-cycle for all three tasks: disassembly, $t\ (153) = 3.74$; assembly, $t\ (145) = 3.87$; and immediate action $t\ (145) = 3.87$; all ps $< .01$. In contrast, only the assembly data revealed reliable differences between GN and GG subjects at mid-cycle, $t\ (143) = 2.53$, $p < .05$. The data were congruent with the intuitive notion that end-of-cycle GO/NO GO classifications were more relevant to end-of-cycle than mid-cycle performance times.

Figure 2 illustrates timed performance for clearing and immediate action tasks for which all four GO/NO GO classifications can be represented. For the

TABLE 12

DECREMENT IN PERCENT PASSING M240 TASKS BETWEEN

MID- AND END-OF-CYCLE TESTS FOR THE M85 DEMONSTRATION CONDITIONS

Task	M85 Demonstration Medium	
	Instructor	Videotaped
Clear	16.5	8.6
Disassemble	1.3	2.9
Assemble	12.8	14.3
Load	16.5	5.7
Immediate Action	-2.6	11.4

TABLE 13

INCREMENT IN MEAN TIMES (SECONDS) TO EXECUTE

M240 TASKS BETWEEN MID- AND END-OF-CYCLE

TESTS FOR THE M85 DEMONSTRATION CONDITIONS

Task	M85 Demonstration Medium	
	Instructor	Videotaped
Clear	3.5	1.0
Disassemble	14.8	15.8
Assemble	24.6	23.6
Load	2.1	1.6
Immediate Action	0.9	-5.6

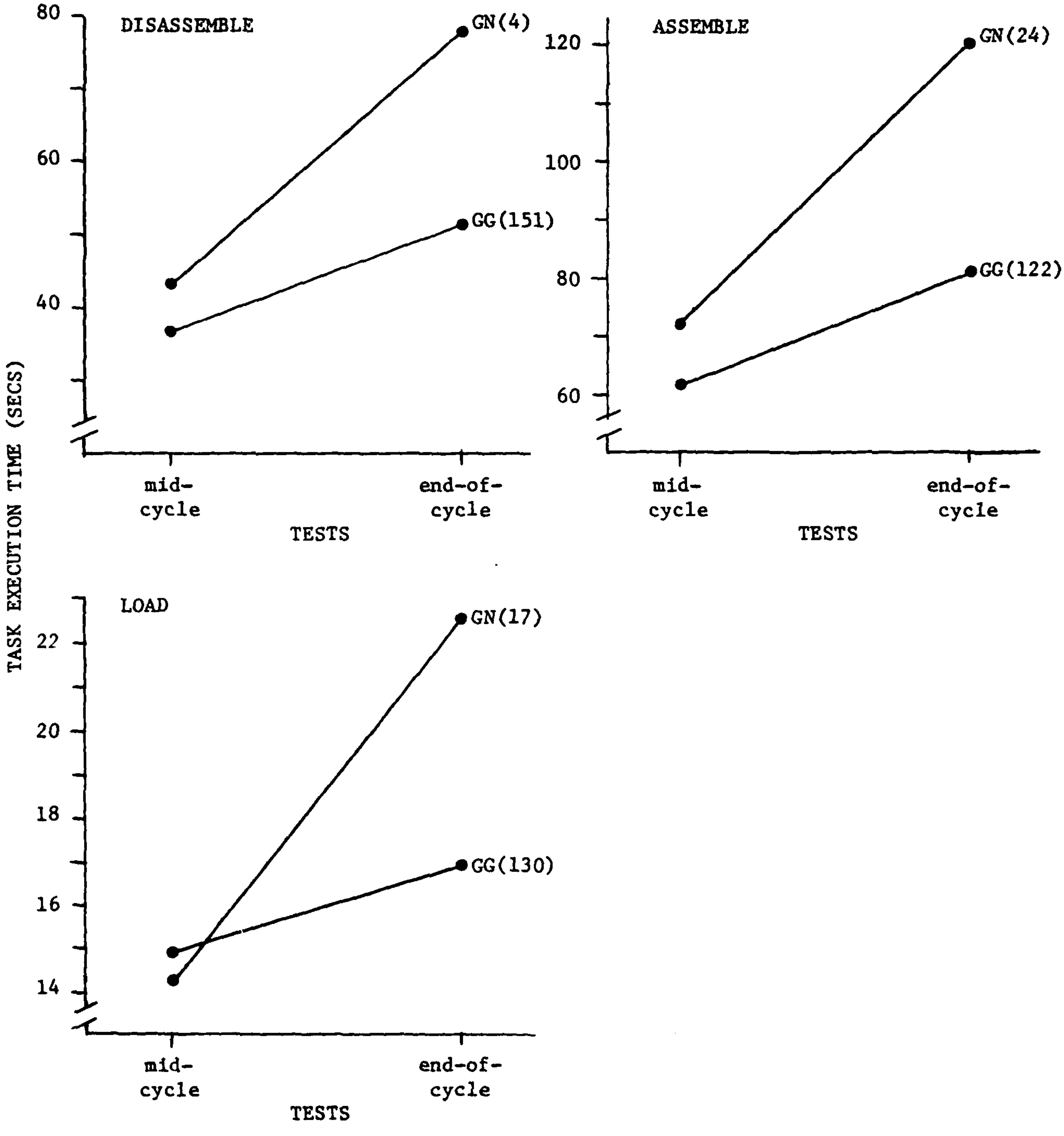

Figure 1. Mean execution times on disassembly, assembly, and loading tasks for GG and GN outcomes. The number of subjects associated with each outcome is given in parentheses.

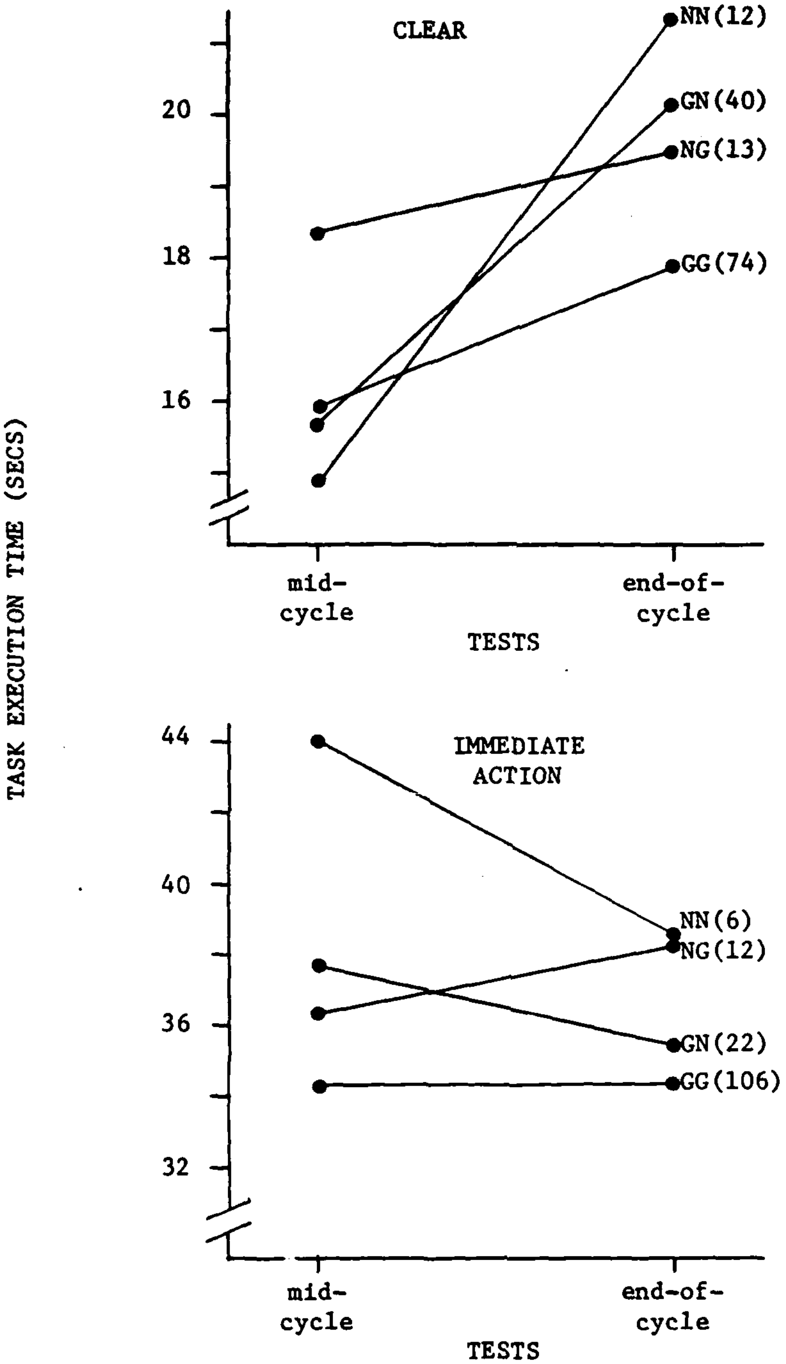

Figure 2. Mean execution times on clearing and immediate action tasks for all four GO/NO GO outcomes. The number of subjects associated with each outcome is given in parentheses.

clearing data in the top panel, the GN and GG curves show the same relationships as the previous three graphs: Analyses showed that despite the increase in time was less for GG than GN subjects, end-of-cycle GOs nevertheless showed significant decrements in timed performance between mid- and end-of-cycle. Also, although students passing the end-of-cycle test (NG and GG) were slower than those failing the test (NN and GN) at the end-of-cycle [t (135) = 2.75, $p < .01$], these differences were not significant on the mid-cycle test. One might have expected that students passing the mid-cycle test (GN and GG) would be faster than those failing (NG and NN) on the mid-cycle test; however, this was not the case. The failure to obtain such differences was probably due to the unrepresentatively fast performance of NN students on the mid-cycle test.

The immediate action data, shown in the lower panel of Figure 2, reveals a different picture than that for the clearing data. Overall times appears to decline between tests, however these differences were not significant. Mid-cycle NO GOs are slower than mid-cycle GOs overall but these and other differences appear to converge at end-of-cycle towards a common level of performance. Conclusions from these data were complicated by the lack of retention decrements. Therefore, further comments were not warranted.

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Appendix A

ANOVAs of M85 Data by Schedule and Company

Source	df	MS	F
Clear			
Schedule (S)	2	0.064	0.91
Company (C)	2	0.358	5.15**
S X C	4	0.031	0.44
Error	411	0.070	
Disassemble			
Schedule (S)	2	1.188	12.28**
Company (C)	2	1.635	16.90**
S X C	4	1.463	15.12**
Error	409	.097	
Assemble			
Schedule (S)	2	0.888	3.78*
Company (C)	2	2.881	12.26**
S X C	4	0.172	0.73
Error	409	0.235	
Load			
Schedule (S)	2	0.033	0.21
Company (C)	2	3.064	19.42**
S X C	4	0.290	1.84
Error	411	0.158	
Immediate Action			
Schedule (S)	2	0.308	1.87
Company (C)	2	0.362	2.20
S X C	4	0.137	0.83
Error	411	0.165	

*$p < .05$
**$p < .01$

Appendix B

ANOVAs of M85 Data by Schedule and Media

Source	df	MS	F
		Clear	
Schedule (S)	1	0.022	0.36
Media (M)	1	0.252	4.12*
S X M	1	0.017	0.27
Error	285	0.016	
		Disassemble	
Schedule (S)	1	0.526	4.00*
Media (M)	1	1.755	13.32**
S X M	1	0.825	6.26*
Error	283	0.132	
		Assemble	
Schedule (S)	1	1.111	4.79*
Media (M)	1	3.985	17.17**
S X M	1	0.172	0.74
Error	283		
		Load	
Schedule (S)	1	0.005	0.03
Media (M)	1	6.659	45.39**
S X M	1	0.115	0.79
Error	285	0.147	
		Immediate Action	
Schedule (S)	1	0.681	4.34*
Media (M)	1	0.265	1.69
S X M	1	0.365	2.33
Error	285	0.157	

* $p < .05$

** $p < .01$

Appendix C

ANOVAs of M85 Data for Companies Not Expecting Tasks on Tests

Source	*df*	*MS*	*F*
	Disassembly		
Schedule (S)	2	1.901	15.93**
Company (C)	1	1.724	14.45**
S X C	2	2.353	19.719**
Error	276	0.119	
	Assembly		
Schedule (S)	2	0.920	3.80*
Company (C)	1	0.003	0.01
S X C	2	0.258	1.06
Error	276		
	Load		
Schedule (S)	2	0.262	1.09
Error	133	0.241	

* $p < .05$
** $p < .01$

Appendix D-1

ANOVA of M240 Percent GO Data by Schedule and Company for Clear Task

Source	df	MS	F
Schedule (S)	2	0.074	0.36
Company (C)	2	0.592	2.86
S X C	4	0.376	1.81
$Error_b$	105	0.207	
Test-Retest (T)	1	1.212	8.37**
T X S	2	0.098	0.68
T X C	2	0.698	4.82**
T X S X C	4	0.664	4.58**
$Error_w$	105	0.1447	

*p < .05
**p < .01

Appendix D-2

ANOVA of M240 Percent GO Data by Schedule and Company for Disassembly Task

Source	*df*	*MS*	*F*
Schedule (S)	2	0.003	0.33
Company (C)	2	0.004	0.42
S X C	4	0.009	0.98
$Error_b$	105	0.009	
Test-Retest (T)	1	0.013	1.42
T X S	2	0.003	0.33
T X C	2	0.004	0.42
T X S X C	4	0.009	0.98
$Error_w$	105	0.009	

*p < .05
**p < .01

Appendix D-3

ANOVA of M240 Percent GO Data by Schedule and Company for Assembly Task

Source	*df*	*MS*	*F*
Schedule (S)	2	0.038	0.46
Company (C)	2	0.144	1.73
S X C	4	0.029	0.35
$Error_b$	104	0.083	
Test-Retest (T)	1	1.000	10.42**
T X S	2	0.041	0.43
T X C	2	0.002	0.02
T X S X C	4	0.120	1.25
$Error_w$	104	0.096	

*p < .05
**p < .01

Appendix D-4

ANOVA of M240 Percent GO Data by Schedule and Company for Load Task

Source	*df*	*MS*	*F*
Schedule (S)	2	0.144	1.82
Company (C)	2	0.004	0.06
S X C	4	0.066	0.83
$Error_b$	105	0.079	
Test-Retest (T)	1	0.919	13.67**
T X S	2	0.063	0.93
T X C	2	0.063	0.94
T X S X C	4	0.038	0.57
$Error_w$	105	0.067	

* $p < .05$
** $p < .01$

Appendix D-5

ANOVA of M240 Percent GO Data by Schedule and Company for Immediate Action Task

Source	*df*	*MS*	*F*
Schedule (S)	2	0.198	1.46
Company (C)	2	0.163	1.20
S X C	4	0.057	0.43
$Error_b$	104	0.135	
Test-Retest (T)	1	0.045	0.36
T X S	2	0.108	0.86
T X C	2	0.234	1.87
T X S X C	4	0.068	0.55
$Error_w$	104	0.125	

$^{*}p < .05$
$^{**}p < .01$

Appendix E-1

ANOVA of M240 Timed Data by Schedule and Company for Clear Task

Source	df	MS	F
Schedule (S)	2	10.561	0.37
Company (C)	2	68.566	2.38
S X C	4	34.458	1.20
$Error_b$	88	28.820	
Test-Retest (T)	1	383.233	18.86**
T X S	2	6.457	0.32
T X C	2	149.147	7.34**
T X S X C	4	7.379	0.36
$Error_w$	88	20.319	

* $p < .05$
** $p < .01$

Appendix E-2

ANOVA of M240 Timed Data by Schedule and Company for Disassembly Task

Source	df	*MS*	*F*
Schedule (S)	2	503.647	2.45
Company (C)	2	614.449	2.98
S X C	4	431.934	2.10
$Error_b$	105	205.952	
Test-Retest (T)	1	12137.144	73.48**
T X S	2	25.923	0.16
T X C	2	22.047	0.13
T X S X C	4	279.222	1.69
$Error_w$	105	165.171	

* $p < .05$
** $p < .01$

Appendix E-3

ANOVA of M240 Timed Data by Schedule and Company Data for Assembly Task

Source	*df*	*MS*	*F*
Schedule (S)	2	1458.406	1.97
Company (C)	2	305.048	0.41
S X C	4	2656.256	3.58**
$Error_b$	104	741.791	
Test-Retest (T)	1	32047.749	70.49**
T X S	2	660.290	1.45
T X C	2	726.525	1.60
T X S X C	4	491.013	1.08
$Error_w$	104	454.630	

* $p < .05$
** $p < .01$

Appendix E-4

ANOVA of M240 Timed Data by Schedule and Company for Load Task

Source	df	MS	F
Schedule (S)	2	133.981	4.47*
Company (C)	2	70.954	2.37
S X C	4	71.881	2.40
$Error_b$	102	29.976	
Test-Retest (T)	1	136.241	5.18*
T X S	2	17.138	0.65
T X C	2	127.966	4.87**
T X S X C	4	13.583	0.52
$Error_w$	102	26.289	

* $p < .05$
** $p < .01$

Appendix E-5

ANOVA of M240 Timed Data by Schedule and Company for Immediate Action Task

Source	*df*	*MS*	*F*
Schedule (S)	2	550.872	10.65**
Company (C)	2	515.811	9.97**
S X C	4	137.009	2.65*
$Error_b$	98		
Test-Retest (T)	1	71.642	2.58
T X S	2	41.036	1.48
T X C	2	185.181	6.66**
T X S X C	4	115.356	4.15**
$Error_w$	98	27.794	

* $p < .05$
** $p < .01$

Appendix F-1

ANOVAs of M240 Timed Data by
Mid- and End-of-Cycle
GO/NO GO Scores

Source	*df*	*MS*	*F*
Clear			
Mid-Cycle (A)	1	43.898	1.37
End-of-Cycle (B)	1	0.884	0.03
A X B	1	30.419	.95
$Error_b$	135	31.906	
Test-Retest (T)	1	490.680	24.67**
(T for GG Subjects)	(1)	(144.027)	(7.24)**
T X A	1	2.620	0.13
T X B	1	155.673	7.83**
T X A X B	1	19.901	1.00
$Error_w$	135	19.888	
Immediate Action			
Mid-Cycle (A)	1	403.816	5.80*
End-of-Cycle (B)	1	247.417	3.55
A X B	1	20.673	0.30
$Error_b$	142	69.611	
Test-Retest (T)	1	50.570	1.41
T X A	1	2.688	0.07
T X B	1	144.485	4.01*
T X A X B	1	42.883	1.19
$Error_w$	142	35.989	

*$p < .05$
**$p < .01$

Appendix F-2

ANOVAs of M240 Timed Data by End-of-Cycle GO/NO GO Scores

Source	*df*	*MS*	*F*
	Disassemble		
End-of-Cycle (B)	1	2118.814	9.58**
$Error_b$	153	221.153	
Test-Retest (T)	1	17527.62	104.00**
(T for GG Subjects)	(1)	(15924.67)	(94.49)**
T X B	1	777.549	4.61*
$Error_w$	153	168.538	
	Assemble		
End-of-Cycle (B)	1	23546.063	39.62**
$Error_b$	150	594.307	
Test-Retest (T)	1	45316.569	148.63**
(T for GG Subjects)	(1)	(23665.580)	(77.62)**
T X B	1	8161.217	26.77**
$Error_w$	150		
	Load		
End-of-Cycle (B)	1	196.525	5.27*
$Error_b$	150	37.279	
Test-Retest (T)	1	775.284	26.30**
(T for GG Subjects)	(1)	(225.246)	(7.64)**
T X B	1	311.039	10.55**
$Error_w$	150	29.479	

*p < .05
**p < .01